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Utah Agricultural College
EXPERIMENT STATION

Bulletin No. 136



**The Commercial Production of
Sugar Beet Seed in Utah**

By
FRANK S. HARRIS

Logan, Utah, January, 1915

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SALT LAKE

UTAH AGRICULTURAL EXPERIMENT STATION

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The Commercial Production of Sugar Beet Seed in Utah

By Frank S. Harris.

History of the beet sugar industry. The production of sugar from beets is a new industry when compared with the length of time that most kinds of crops have been used by man. It was only about 150 years ago that sugar was extracted from beets even in the laboratory, and at that time the percentage of sugar was so low that the expense of extracting was more than the sugar was worth. Just a little more than 100 years ago the first beet sugar factories were built, but it was nearly fifty years after this time before the industry became thoroughly established in Europe. In the United States an attempt was made to manufacture beet sugar as early as 1830, but practically nothing was done till in the seventies. Since that time growth has been somewhat irregular, but at present there are about sixty-six factories operating in this country.

In 1747 Margaff, a Prussian chemist, was able to get but about 5 per cent of sugar from beets. It was, therefore, necessary to breed strains of beets having a higher sugar content in order to extract sugar profitably on a commercial scale. The most vigorous kind of scientific selection was carried on, with the result that beets containing from 14 to 20 per cent of sugar are now regularly produced.

This intensive selection, extending over a comparatively brief period, has not been able to permanently fix in the sugar beet the desirable high sugar content. It is necessary to continue the selection or the percentage of sugar rapidly decreases to the point where the manufacture of sugar can no longer be carried on at a profit. With most other kinds of crops seed can be taken from the ordinary commercial product; hence the getting of seed is a very simple matter. With sugar beets, on the other hand, good seed is obtained only by a great amount of work, carried on in a systematic manner.

Present source of seed. It takes about 7,500,000 pounds of sugar beet seed each year to supply the needs of the United States. Less than one-twentieth of this is produced in the country and the remainder has to be imported from Europe. This means that nearly a million dollars must be sent out of the country each year for this one article. Practically all of the sugar beet seed is produced in Germany, France, Russia and Austria-Hungary.

Disadvantages of importing seed. The importation of seed is attended by many disadvantages. In the first place, the entire beet sugar industry is threatened in times of war, when, for any reason, it would be impossible to import seed. This condition cannot help but detract to a certain extent from the stability of the industry.

Perhaps the most important disadvantage of imported seed is that the breeding has been done for conditions unlike those in which the beets are to be raised. The climate and soils of Europe are different from those of the beet-growing sections of the United States and there is doubtless a great loss in yield and sugar content due to the fact that the foreign seed is not exactly suited to local conditions.

When the source of supply is not near at hand there is likely to be difficulty in adjusting any little business differences which at times may become annoying. There is also a likelihood that in times of scarcity of good seed the best will be held in Europe for home planting and inferior seed sent to America.

Tests made at Schuyler, Neb., as early as 1893 gave better yields of beets with higher sugar content from domestic seed than from imported seed. The same result has been found in many other places since that time.

Utah adaption to seed production. At the Utah Experiment Station during the last three years tests have been conducted to compare imported seed with that produced on the station farm. The result given for imported seed is the average of seed received from a number of foreign seed companies. In all cases it was represented to be very superior seed. The home-grown seed is from strains raised on the station farm for ten years.

TABLE NO. 1.—COMPARISON OF BEETS RAISED FROM IMPORTED AND FROM UTAH EXPERIMENT STATION SEED.

Year	UTAH SEED		IMPORTED SEED	
	Per Cent Sugar in Beets.	Yield Beets Tons per Acre	Per Cent Sugar in Beets.	Yield Beets Tons per Acre
1912	18.97	22.68	18.25	25.15
1913	16.40	21.28	15.58	26.08
1914	16.25	25.06	15.45	29.03

The table shows that the beets from home-grown seed were higher in sugar content during each of the years than the beets from imported seed, although the yield was somewhat higher for the imported seed.

Germination tests were conducted in 1913 to compare the imported and the home-grown seed with the following result expressed in number of sprouts to 100 seed balls: Imported seed—a, 53; b, 79, and c, 124, while the average of six samples of home-grown seed was 126. Each seed ball contains a number of germs, hence there are often more sprouts than seed balls. It will be noted that of the three samples of foreign seed not one of them was equal to the home seed in germinating power.

The climate of Utah seems well adapted to the production of sugar beet seed. The use of irrigation to control the soil moisture and the warm, dry weather during the season when seed is growing make an almost ideal combination. In the twelve years since the Experiment Station began raising sugar beet seed there has not been a single year of failure.

The following table shows the average weight of seed produced by mother beets during a number of years:

**TABLE 2.—AVERAGE WEIGHT OF SEED PRODUCED
BY MOTHER BEETS.**

Year	Number Mothers Tested	Average Weight of Seed Per Beet. Grams*
1905-----	309	368.9
1906-----	66	356.5
1907-----	178	714.6
1908-----	200	722.6
1909-----	395	405.0
1910-----	348	282.3
1911-----	470	374.3
1912-----	135	393.4
1913-----	53	263.7
Average-----		431.2 grams

*There are 453 grams in one pound.

As an average of nine years' results each mother beet produced 431.2 grams, or nearly one pound of seed. Under commercial conditions the yield would probably be considerably less. There are about 7000 beets to the acre where seed is raised commercially, hence a good yield would be obtained if only half this above quantity were produced.

Freedom from insects. Utah is exceptionally free from serious insect pests of seed beets. The false chinch bug, which has at times practically ruined the seed crop in the other sections, has never been seriously injurious in this state. The beet leaf-hopper, which causes the curly leaf condition, is the only pest that has been known to injure seed raising in this section, and it is much less injurious here than in many other localities, only one crop in the twelve years having been damaged at all.

Difficulties of seed production. The commercial production of sugar beet seed is beset with many difficulties. Probably the greatest of these is the maintaining of a strain of beets with high sugar content and yield. The fact that the sugar

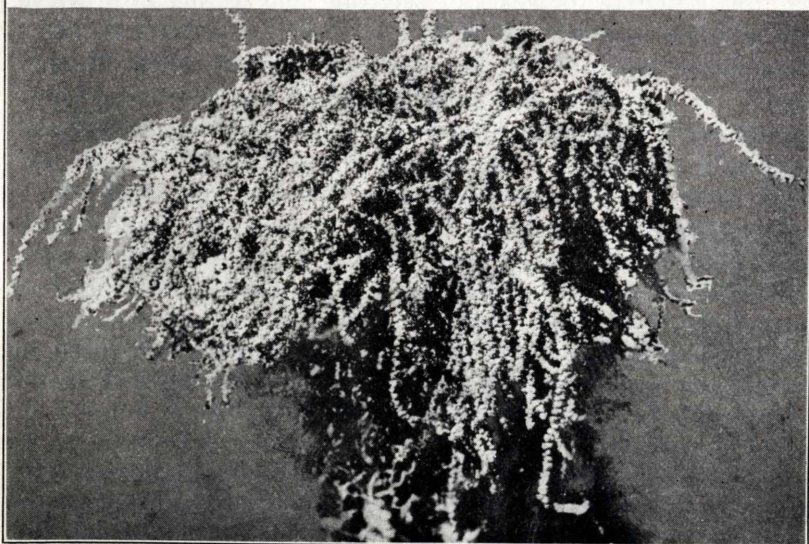
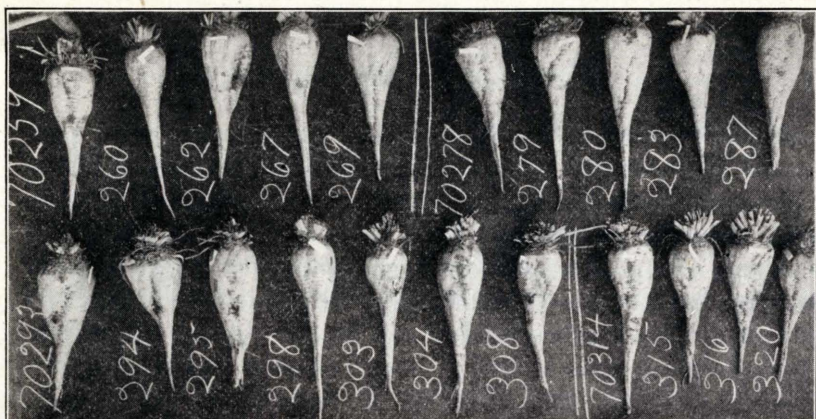


Plate 1. Upper figure—Typical selected beets. Middle figure—Seed being produced from selected beets. Lower figure—A good mother beet, showing seed.

beet has, in recent times, been bred up from a plant with comparatively low sugar content to its present high standard makes it somewhat unstable, and unless selection is continued deterioration occurs very rapidly.

This continuous selection requires men who are familiar with the principles of breeding, as well as men who have skill in making chemical analysis of the mother beets. Those who raise the mother beets and produce the seed must also be acquainted with the method of handling the crop. All of these special requirements delay the introduction of the beet seed industry into a new region. The time necessary to elapse, from when selection is begun until the first seed is ready for market, is so great that investors hesitate to put their money into the business. Those who want quick returns are not willing to spend the time necessary to build up a business based on the sale of products of merit.

The production of sugar beet seed, therefore, is not a business for the individual farmer with limited resources, but can best be done by a company with resources to build up a good substantial business, wherein the profits will depend on the establishment of a reputation.

General Methods. The approved method of producing seed requires a number of years of selecting and testing in order to get a strain possessing the desired qualities. Seed is saved from tested beets of selected strains. This is called "mother seed." This mother seed is then planted and the beets which are obtained used as mother beets to produce the commercial seed two years later. Roots only are produced the first year after seed is planted. These must be dug and stored over winter, and the second year they are set out and produce seed.

The difficult part of the operation is the securing of suitable "mother seed." After this is obtained the individual farmer can raise the commercial seed.

Getting the "mother seed." The "mother seed," used in raising the mothers which produce the commercial seed, is obtained only at considerable expense and after a number of years of work.

The procedure usually carried out is about as follows: The first year a great many beets of desirable size and shape are analyzed for sugar. The better individuals are siloed and the second year are planted and produce seed. The third year the seed from each beet is planted separately and the resulting

beets analyzed. From this analysis it is possible to tell which of the original beets with a high sugar content are able to transmit to their progeny this necessary quality. The poor strains are discarded and the good ones siloed, to be used the fourth year in producing the "mother seed." The "mother seed" is planted the fifth year and the beets obtained from it produce the commercial seed the sixth year from the time the work was begun.

It is not safe to use all individual beets that have a high sugar content without making a test to see if that quality is transmitted, since the high sugar content may be due to the conditions under which the beet grew and not to its intrinsic high quality. It is not the mother beet with high sugar content that is desired, but the mother whose progeny will be high in sugar. In testing strains it is a good thing to have standard seed for comparison growing in different parts of the test field.

In getting beets from which the commercial seed is produced the roots are left considerably thicker in the rows than where regular beets are to be raised. About eight pounds of seed are used to the acre and the plants are not thinned. This method is used in order to save land and also to save labor in handling the beets. Less storage space is required for the small beets than for those of full size. Being small does not seem to reduce the amount of seed produced. These small beets are called *stechlinge* or *fingerlings*.

Siloing. One of the most important operations in connection with seed production is the storing over winter, or siloing, of the beets that are to be used the next year in raising seed. At the Utah station quite a number of methods of siloing beets have been tested and a number of these have given good satisfaction. The important things to be kept in mind are that the beets must not be allowed to dry out or to heat. There must be sufficient ventilation to allow the carbon dioxide produced by normal respiration to escape and at the same time not enough to dry the beets. The beets must have sufficient covering to prevent freezing, but not enough to cause heating.

Beets stored in dry sand kept the best of any method which was tried, although this method is perhaps not practical except for the comparatively few mother beets that have been individually analyzed and are more likely to decay on account of the wound caused when the core is removed for analysis.

For the large number of beets used in producing the commercial seed perhaps the best way is to silo them right in the field. This is done by piling the beets on top of the ground or in a shallow trench in ricks five or six feet wide, and then covering them with straw and soil or with soil alone. Only a light covering is given at first and more added as the weather gets cooler.

Ventilators should be placed in the ricks every few feet to allow carbon dioxide to escape and fresh air to enter. If a long rick is made the beets should be divided every twelve or fifteen feet by straw or earth, so that if decay begins at any point it will not destroy all the beets in the silo. Before placing the beets in the silo it is a good thing to remove the tops, leaving enough of the crown and tops so that growth will begin the next spring. If mother beets are allowed to wilt before they are planted the yield of seed is greatly reduced.

A test was made in Logan in the fall of 1912 to see if the beets could be siloed right in the ground where they grew to save handling the roots. Four plants were staked off in the field of beets and were covered with various materials as follows: (1) Straw 8 inches deep, (2) straw 8 inches and earth 4 inches deep, (3) manure 6 inches deep and (4) the tops of the beets were covered by a plow running along the furrow. Table 3 shows the results:

TABLE 3.—THE BEETS LIVING OVER WINTER AND SEED PRODUCED NEXT YEAR BY DIFFERENT METHODS OF COVERING IN THE FIELD.

Covering	No. Beets Living over Winter	Seed Produced
Manure -----	197	26 lbs.
Straw -----	105	21 lbs.
Straw and soil -----	106	7 lbs.
Covered with plow soil ----	0	0

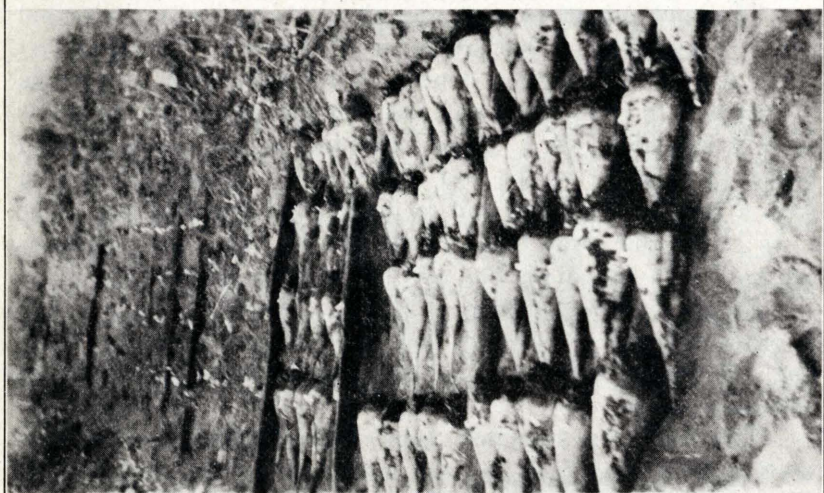


Plate II. Upper figure—Silo of Stechlinge. Middle figure—Method of storing selected beets in sand. Lower figure—Field of sugar beet seed.

The manure was most effective in preserving the beets, while none survived when covered with a plow furrow.

It is doubtful if preserving mother beets without digging can be made practical.

Planting. The mother beets can be planted considerably earlier in the spring than the beet seed, since the old beets are not as sensitive to frost as the young plants starting from the seed. It is probably needless to say that the land should have been plowed deeply. Experiments with a number of methods of planting and distances between plants have been made and the following method adopted as a result:

The land is marked each way about thirty inches apart and a beet dropped at each crossing of the marks. The best distance apart will, of course, depend on conditions. A long spade is pushed into the ground and the beet put in behind the spade as it is moved forward. It is important to get the beets well below the surface of the soil. The crown should be covered with a small quantity of soil to protect the budding top. The rows being the same distance apart each way, the cultivator can be run in two directions and much hand labor saved.

Caring for the seed crop. Cultivation should be begun early in order to conserve moisture and prevent the weeds from starting. If proper cultivation is given at first but little will be necessary later.

The seed crop does not require many irrigations, but it is very important to have the soil moist during the time seed is forming. But little work is necessary between planting and harvesting aside from cultivation and one or two irrigations.

Harvesting and threshing. Since the seed does not ripen evenly it is necessary to go over the field and cut some of the plants before all are ripe. The ripening period may extend over a number of weeks. The cutting is done with a sickle and the seed stocks piled in the field to dry before threshing. It usually pays to go over the field after harvest with a brush and dustpan to glean seed that has fallen to the ground in cutting. Threshing can be done with a regular grain threshing machine and from fifteen to twenty tons of seed can be threshed in a day.

Cleaning. After the seed is threshed there is always a certain amount of dirt and stems remaining. These are best removed by running the seed over a revolving canvas, which allows the seed to roll off and at the same time carries the stems

away. The dirt and chaff are removed with a fanning mill before the seed is run over the canvas. The seed-cleaning machines may be purchased from manufacturers in Germany or may be made at home for about \$75.00. A good machine can be made to clean about a ton of seed in a day.

Yield and cost. The figures already given show that the average seed produced by 2154 mother beets, raised in breeding work during nine years, was but slightly less than one pound to the beet. Since in raising commercial seed there are about 7000 beets to the acre if planted thirty inches apart each way, between 6000 and 7000 pounds of seed might be expected to the acre if all beets did as well as those in the breeding tests. When seed is raised on the commercial scale, however, less care is given the individual beets and the yield is considerably less.

During the years 1912, 1913 and 1914 tests were made at the Experiment Station at Logan on the commercial production of sugar beet seed. From one to two acres of land were used each year and various methods of planting, handling, and harvesting investigated. The yields obtained are shown below. These were not as large as they would have been had not tests been carried on. For example, in the tests some of the beets were placed four feet apart each way, which proved to be a waste of land. The following yields of first-class seed were obtained:

1912 -----	1190 pounds per acre
1913 -----	1354 pounds per acre
1914 -----	1571 pounds per acre
<hr/>	
Average -----	1372 pounds per acre

It will be noted that the yield increased each year. This was due, in part at least, to the fact that we learned each season how to handle the crop better; and it is believed that by using the experience already gained it is possible to get from 1500 to 2000 pounds of seed to the acre on the average.

In figuring the value of the seed it will be found that 1372 pounds at 12½ cents per pound would be \$181.50, or at 15 cents per pound would be \$205.80, which represents the value of crop produced on one acre.

The expense of raising this seed is rather high. The following figure estimates of the cost of raising an acre of sugar beet seed are based on over three years' work and on the best information that is available.

Estimated cost of raising one acre of sugar beet seed:

Rent of land	\$20.00
Plowing and preparing land.....	4.00
Hauling beets from silo and planting.....	15.00
Cultivating and irrigating	5.00
Hoeing	2.00
Cutting seed	4.00
Threshing and cleaning seed	15.00
Cost of mother seed and stecklinge.....	30.00
	<hr/>
	\$95.00

These figures show that there is a very good profit in the industry, even during the years of lowest yield and at a price considerably lower than it is necessary for the farmer to pay.

Outlook. The outlook for Utah as a sugar beet seed producing section is promising. The climate and soil seem well adapted to the growth of seed, and the availability of irrigation water makes a uniform yield doubly certain.

The difficulties in the way of establishing this industry at once are: First, the fact that it takes a number of years to get mother seed of high standard in sufficient quantities to produce commercial seed; and second, it is necessary to have men who are acquainted with methods of handling the industry. The industry cannot be developed by individual farmers, but must be fostered by companies, or men having sufficient capital to carry it during the first years until it is established. It is a business requiring capital as well as special training, but from experiments and experience of the Utah Experiment Station the industry should be able to pay a good dividend in Utah.